A university built amidst challenges

The Singapore Management University’s new campus comprises the Bras Basah Campus and the Victoria Campus, also known as the Administration Block. Work on the Bras Basah Campus commenced in 2001 and TOP was obtained on 30 May 2005, while the work on the Administration Block began in 2002 with TOP obtained on 8 June 2005.

The city campus at the Bras Basah area was developed over a site of five parcels clustered in and around the civic and cultural district. The new 4.5 hectare purpose-built city campus looked into every intricate detail from the foundation level, classroom and building design, amenities, public access, conservation to landscaping etc, encouraging open, flexible and interactive learning as well as interaction between University and members of the public.

The SMU campus allows free and easy access to the SMU community as well as the public. The linkway at the concourse level in the basement protects users from the elements, allowing pedestrians to move under cover from one end of the campus to the other. At street level, SMU has been designed to provide open space for public access.

At the heart of the campus, the Li Ka-shing Library and Campus Centre form a special relationship with the Art Museum and History
Museum, each fronting one side of the green. The SMU building plans have been carefully and specially designed to allow for a clear line of sight between the Art Museum and History Museum.

The campus is designed to be in harmony with its existing landscape setting. Existing trees are preserved where practical and new trees are being added along street frontages to shade the main pedestrian routes. The buildings are always seen against a foreground of trees with the park landscape beyond.

The Bras Basah campus comprises the School of Information Systems/Campus Centre, the Li Ka-shing Library, the Lee Kong Chian School of Business, the School of Accountancy, and the School of Economics & Social Sciences.

The project was phased into two contracts, one being the piling and basement contract and the other is the main building (superstructure) contract.

Foundation system

In general, the bored piling system was adopted for this project with Contiguous Bored Piling (CBP) instead of the diaphragm retaining wall system because of the underground soil conditions.

Special considerations such as intensive ground monitoring instrumentation for the whole site and tunnel real time monitoring were carried out during the construction period, especially during the excavation period. Kestridge, bi-directional load test and PDA test were carried out for the piles. Interestingly, trail monitoring was set up to monitor the jet grout pressure for the JMM (Jet Mechanical Mixing) technique. This was to ensure the jet grouting pressure would not exceed the allowable limit for the existing tunnel.

Due to the existing MRT tunnel, only a maximum 10 m excavation below ground level could be carried out in this site. However, the 10 m excavation was not applied to the entire site. In general, the basement is 6.5 m to 10 m below ground level.

Structural system

For the substructure, the conventional reinforcement beam and slab system was used because of the major transfer structure due to the existing and future (CCL) MRT tunnels. For the superstructure, precast staircase, wall and post tensioning beam and slab system was adopted to minimise the labour force.

Challenges

Some of the challenges the team faced included the location of the existing North-South MRT tunnels under part of the proposed buildings. The Lee Kong Chian School of Business is built directly over the North-South MRT tunnels where they happen to converge right where the piles should be. As the closest pile could not be more than 3 m from the tunnel edge, a 3 m thick pile raft was built over the tunnels to support the columns for this building.

Another challenge was the interfacing development of the new MRT Circle line, in particular, the Museum station and related tunnels. Part of the School of Economics & Social Sciences Building is on top of the 10 m wide Stamford canal. Complicated by the existing North-South MRT tunnel, the ‘undermining’ technique was adopted to construct the foundation for this portion of the building.

Due to the surrounding conservation buildings, extra
precautionary measures had to be taken during basement construction. There was difficult underground soil condition, comprising mainly bouldery clay. A lot of construction had to be carried out underneath the busy roads. Amidst stringent Land Transport Authority (LTA) regulations, extra caution had to be adhered to so as not to affect the roads during construction. A comprehensive pre-conditional survey was conducted and monitoring instrumentation was also installed within surrounding buildings. In addition, daily ground monitoring on groundwater behaviour and ground settlement monitoring was carried out during basement excavation stage.

There were existing services such as Singtel Telecom cables, Powergrid 66 kV cables and sewer pipes, which had to be contended with during the construction. Instead of diverting these services, which would have cost a few million dollars, the project team decided to provide protection and supported the services during the excavation.

**Special construction techniques**

There were two special construction techniques that were carried out during the construction of the SMU Bras Basah campus. One was the Jet Mechanical Mixing (JMM) technique to improve the soil strength during the construction of the Li Ka-shing Library Building. And the other was the Undermining construction technique underneath the Stamford canal to build the School of Economics & Social Sciences Building.

**JMM technique**

The JMM technique is a type of chemical grouting that is similar to Jet Grout Filing but it uses chemicals instead. The pressure is not as high as JGP as it had to be done on top of the MRT tunnel where the ground is very soft. As the North-South MRT tunnels were running underneath the Library, there was the fear that the excavation work may lead to heaving problems. The JMM technique was thus introduced to minimise soil heaving and tunnel movement.

Although JMM was done at a small portion of the Library only, there were very stringent controls when using this technique which was done right 2 m above the tunnel. As this is the basement slab, the JMM had to be done underneath it so as to provide a platform for the building. The LTA had stringent controls when using the JMM. When this tube is pushed down to the ground, before the supervisor can turn in to replace the ground with the soil, there is a lock to ensure that the maximum depth they can go is adhered to. And because of this lock not anyone can do this job. The pressure is also controlled. The project team carried out some trials before doing the actual JMM at the Library building.

During the whole construction period, the project was under a 24
hour monitoring system. Everyday, three readings were taken for the tunnel for real time monitoring. The LTA requirements are such that the tunnel is not supposed to move more than 15 mm and the project team has to be constrained within this range. There were monitoring equipment inside the tunnel which were all automated and the system was linked to key personnel’s mobile phones for emergencies.

**Undermining**

Part of the School of Economics & Social Sciences is right above the 10 m wide Stamford Canal and under this canal are two tunnels, also of the North-South MRT Line. The project team obtained approval from the Drainage Department to pile through the canal and to have transfer beams below it.

This stage of the project had to be done carefully with underpinning micropiles to support the canal during excavation. The team used the undermining method, which is similar to the conventional mining techniques. As they excavate a portion under the canal, they put in the temporary struts, put in the rebar and cast the micropiles. The soft soil and being underneath the Stamford Canal, meant the excavation work had to be done at a safe distance.

The contractor decided to use 300 mm micropiles, instead of the originally planned 1,200 mm bored piles. So the seven numbers of bored piles were replaced by 10 micropiles each which were punched through the Stamford Canal and a 2 m deep transfer beam was built under the canal, over the MRT Tunnels.

**Materials used**

- a. Volume of concrete - approximately 76,600 cu m
- b. Reinforcement bars - approximately 15,812,000 kg
- c. Prestressed tendons - approximately 932,000 kg
- d. Structural steelworks - approximately 1,444,000 kg

Precast concrete was used mainly on staircases and the facade only.

**Conclusion**

The total project cost is about S$425 million, including the SMU Administration Building. The SMU campus is already open for lectures and lessons, with term starting on 22 August. Building a 4.5 hectare campus right in the middle of the city area certainly posed some highly formidable challenges, which the project team overcame with technical ingenuity. The team’s efforts are to be lauded for building the campus against all odds, especially for sticking to the stringent safety regulations imposed by the authorities and the client.